Bansilal Ramnath Agarwal Charitable Trust's

Vishwakarma Institute of Technology

(An Autonomous Institute affiliated to Savitribai Phule Pune University)

Structure & Syllabus of

B. Tech. (Chemical Engineering)

Pattern 'B22/C22/D22'

Effective from Academic Year 2022-23

B.Tech. Chemical Structure Pattern C22 (applicable w.e.f. AY 22-23)

Third Year Module - V

Subject head	Course code	Course name	Contact hours per week			Credits
			Theory	Lab	Tut	
S1	CH3231	HEAT TRANSFER	2	2	1	4
S2	CH3233	CHEMICAL ENGINEERING THERMODYNAMICS	2	2	1	4
S3	CH3235	CHEMICAL REACTION KINETICS	2	2	1	4
S4	CH3237	MASS TRANSFER OPERATIONS	2	2	-	4
S5	CH3287	ENGINEERING DESIGN AND INNOVATION – V	-	12	-	6
S6	CH3291	DESIGN THINKING - I	-	-	1	1
		Total	14	16	3	23

Third Year Module - VI

Subject head	Course code	Course name	Contact hours per week			Credits
			Theory	Lab	Tut	
S1	CH3232	INSTRUMENTATION AND PROCESS CONTROL	2	2	1	4
S2	CH3234	PROCESS EQUIPMENT DESIGN	2	2	1	4
S3	CH3236	SEPARATION TECHNIQUES	2	2	1	4
S4	CH3238	CHEMICAL REACTION ENGINEERING	2	2	-	4
S5	CH3288	ENGINEERING DESIGN AND INNOVATION – VI	-	12	-	6
S6	CH3292	DESIGN THINKING – I	-	-	1	1
		Total	13	16	3	23

FF No. : 654

CH3231::HEAT TRANSFER

Course Prerequisites: None

Course Objectives:

1. Distinguish between mechanisms of heat transfer and derive basic heat transfer equations from first principles.
2. Solve convection heat transfer problems.
3. Solve boiling and condensation problems.
4. Solve radiative heat transfer problems
5. Design simple heat exchangers
6. Solve basic evaporator calculations

Credits:4

Teaching Scheme Theory:2 Hours/Week

Tut:1 Hours/Week

Lab: 2 Hours/Week

Course Relevance:

SECTION-1
Introduction to heat transfer, heat transfer mechanisms: conduction, convection and radiation heat transfer, conduction heat transfer law, Steady state heat conduction through composite slab, cylinder, sphere, critical thickness of insulation, unsteady state heat conduction: Lump heat parameter model, dimensional analysis : Rayleigh's and Buckingham's method, Newton's law of cooling, heat transfer correlations in natural and forced convection systems, Heat transfer from extended surfaces/fins, Boiling Heat Transfer, condensation Heat Transfer, Nusselt's theory, condensation on vertical/horizontal plate and cylinder, condensation on bank of horizontal tubes.
SECTION-1I

Emission from the surface, Concept of black, real and gray surface, Laws of black body radiation, Directional nature of thermal radiation, concept of solid angle and intensity, concept of diffuse surface, Kirchhoff's law. Heat transfer by radiation between two black surface elements, Concept of shape factor, Classification of heat exchangers, flow arrangements, Concept of overall heat transfer coefficient, fouling factor, concept of LMTD, effectiveness-NTU method for heat exchanger design, selection of heat exchangers, concept of evaporation, performance evaluation of tubular evaporators: capacity and economy, boiling point elevation, type of evaporators, single and multiple effect evaporation, material and energy balance calculations, preliminary evaporator design.

List of Practicals: (Any Six)

1. Determination of thermal conductivity of insulating powder
2. Determination of thermal conductivity of composite wall
3. Determination of thermal conductivity of a metal rod and to study effect of temperature on its thermal conductivity
4. Determination of heat transfer coefficient for convection heat transfer
5. Determination of efficiency temperature distribution along the fin in natural convection
6. Determination of efficiency temperature distribution along the fin in forced convection
7. Verification of Stefan-Boltzmann constant
8. Determination of emissivity of a nonblack surface

List of Course Projects:

1. Analysis of heat exchangers performance in double pipe heat exchanger
2. A project on design of heat exchanger or evaporator
3. Determination critical heat flux in pool boiling
4. Heat Transfer Analysis of Engine Cylinder Fins Having Triangular Shape
5. Design of Solar air cooler with heater
6. CFD analysis of double pipe heat exchanger
7. Study of evaporators
8. Design of Critical insulation for cylindrical geometry
9. Design of Critical insulation for spherical geometry
10. 2D Numerical analysis of 2-dimensional conduction problem.
11. Dimensional analysis of experimental data from conduction process
12. Dimensional analysis of experimental data from convection process

13. Dimensional analysis of experimental data from radiation process
14. Data fitting for conduction process
15. Data fitting for convection process

List of Course Group Discussion Topics:

1. Best mode of heat transfer for liquid liquid system
2. Best mode of heat transfer for Solid solid system
3. Best mode of heat transfer for liquid solid system
4. Critical insulation critical parameter for insulation of Chemical equipments
5. non-dimensional number need in convection
6. Usefulness of non-dimensional number in critical insulation
7. Radiation crucial heat transfer process
8. Radiation in nuclear reactor: crucial process
9. Nuclear reactor accident, role of heat transfer
10. Need of passive cooling in nuclear reactor
11. Heat transfer analysis of Chernobyl nuclear reactor accident
12. Heat transfer analysis of Fukushima Nuclear Disaster nuclear reactor accident
13. Windscale Fire Nuclear Disaster
14. Three Mile Island Nuclear Accident
15. 15. Kyshtym Nuclear Disaster.

List of Home Assignments:

Design:

1. Design of water heater
2. Design of furnace
3. Design of insulation thickness
4. Design of multiple effect evaporator
5. Basic design of heat exchanger
6. Design of solar heater

Case Study:

1. Multiple effect evaporator in sugar industry
2. Multiple effect evaporator in
3. Radiation across the planets
4. Furnace heat transfer
5. Salt based power plant heat transfer

Blog

1. Fukushima Nuclear Disaster nuclear reactor accident
2. Windscale Fire Nuclear Disaster
3. Three Mile Island Nuclear Accident
4. Kyshtym Nuclear Disaster.
5. Multiple effect evaporator

Surveys

1. Heat transfer in solar power plant
2. Heat transfer in thermal power plants
3. Study on heat transfer in furnaces
4. Survey of convection heat transfer in heat exchanger
5. Survey on heat transfer in condensation process
6. Survey on heat transfer in boiling system

Suggest an assessment Scheme:

Suggest an Assessment scheme that is best suited for the course. Ensure 360 degree assessment and check if it covers all aspects of Blooms Taxonomy.

ESE	*HA*	*CP*	*VIVA*	*GD*
20	*20*	*20*	*20*	*20*

MSE - Mid Semester Examination
ESE - End Semester Examination
HA - Home Assignment
LAB - Laboratory
CP - Course Project
VIVA - Viva voice
GD - Group Discussion

Text Books: ***(As per IEEE format)***

1. D. Q. Kern, Process Heat Transfer,
2. MCabe and Smith, Unit Operation of Chemical Engineering, MCgraw Hill, 7th Edition
3. John Leinherd, Heat transfer, Plogiston press

Reference Books: ***(As per IEEE format)***

1. Richardson and Coulson, Chemical Engineering Design (Vol-6)
2. Eduardo Cao, Heat transfer in process engineering, MCgraw hill, 6th Edition

Moocs Links and additional reading material: www.nptelvideos.in
https://www.youtube.com/watch?v=qa-PQOjS3zA&list=PL5F4F46C1983C6785
https://www.youtube.com/watch?v=ACjR7MIFaFw&list=PL5F4F46C1983C6785&index=3
https://www.youtube.com/watch?v=gIf-aIZz7-0&list=PL5F4F46C1983C6785&index=6
https://www.youtube.com/watch?v=bkWw7o45JmI&list=PL5F4F46C1983C6785&index=8
https://www.youtube.com/watch?v=qsombY4Q7ZY&list=PL5F4F46C1983C6785&index=9
https://www.youtube.com/watch?v=atQ-SWZFWF4&list=PL5F4F46C1983C6785&index=13
https://www.youtube.com/watch?v=63bKIq0Xwbw&list=PL5F4F46C1983C6785&index=17

Course Outcomes:

The student will be able to

1. Distinguish between mechanisms of heat transfer and derive basic heat transfer equations from first principles.
2. Solve convection heat transfer problems using empirical correlations.
3. Solve boiling and condensation problems using empirical correlations.
4. Solve radioactive heat transfer problems.
5. Design simple heat exchangers and condensers.
6. Design evaporators, furnaces and reboilers.

CO PO Map

CO/ PO	**PO: 1**	**PO: 2**	**PO: 3**	**PO: 4**	**PO: 5**	**PO: 6**	**PO: 7**	**PO: 8**	**PO: 9**	**PO: 10**	**PO: 11**	**PO: 12**	**PSO :13**	**PSO :14**
CO: 1	**2**	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**2**	**2**	**0**	**1**	**3**	**1**
CO: 2	**2**	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**2**	**2**	**0**	**1**	**3**	**1**
CO: 3	**2**	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**2**	**2**	**0**	**1**	**3**	**1**
CO: 4	**2**	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**2**	**2**	**0**	**1**	**3**	**1**
CO:	**2**	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**2**	**2**	**0**	**1**	**3**	**1**

5														
CO: 6	2	2	2	2	2	1	1	2	2	2	0	1	3	1

CO attainment levels

CO	Attainment level
CO:1	3
CO:2	3
CO:3	3
CO:4	4
CO:5	5
CO:6	5

Future Courses Mapping:
Mass Transfer, Chemical Reaction Engineering, Transport Phenomena

Job Mapping:
Core Chemical Engineering industrial job
Chemical Engineering Design job
Chemical Engg. research jobs

FF No. : 654

CH3233::CHEMICAL ENGINEERING THERMODYNAMICS

Course Prerequisites:

Course Objectives:

1. To understand thermodynamic properties of pure fluids
2. To understand thermodynamic properties of solution and application
3. To understand thermodynamic phase equilibria
4. To understand thermodynamic chemical reaction equilibria

Credits:4

Teaching Scheme Theory:2 Hours/Week
Tut:1 Hours/Week
Lab: 2 Hours/Week

Course Relevance:

SECTION-1
Thermodynamic Properties of Fluids: The fundamental property relations for homogeneous phases, Maxwell relationships, relations between thermodynamic properties, residual properties, residual properties by equations of state, two-phase systems, Thermodynamic diagrams *Solution Thermodynamics and applications: Single phase mixtures and solutions; ideal solutions; partial molar properties; chemical Potential, effect of temperature and pressure on chemical potential, fugacity and fugacity Coefficient – pure species and species in solution, activity and activity coefficient, ideal solution Model, Non-ideal Solutions; excess Properties; generalized correlation for fugacity coefficient, activity coefficient models, Gibbs-Duhem equation; criteria for thermodynamic equilibrium; models for the excess Gibbs energy, property changes of mixing, heat effects of mixing Process*
SECTION-1I

Phase Equilibria: The nature of equilibrium, criteria of phase equilibrium, Phase rule, Duhem's Theorem, Introduction to VLE, Raoult's law, VLE by modified Raoult's law, dew point and bubble point calculations, flash calculations, determine whether azeotrope exist, Equilibrium and stability, Introduction to liquid -liquid equilibrium (LLE), vapor – liquid – liquid equilibrium (VLLE), solid liquid equilibrium (SLE) and solid vapor equilibrium (SVE), equilibrium, adsorption of gases on solids

Chemical Reaction Equilibria: The reaction coordinates, criteria for equilibrium to chemical reactions, the standard Gibbs free energy change and the equilibrium constant, effect of temperature on equilibrium constant, evaluation of the equilibrium constant, relation of equilibrium constant to composition, calculation of equilibrium conversion for single reaction, Phase rule and Duhem's theorem for reacting systems.

List of Practicals: (Any Six)

1. To derive and apply of Maxwell's Relation
2. To apply Clapeyron equation and Clausius Clapeyron equation
3. determine thermodynamic properties like internal energy, enthalpy for pure fluids
4. To determine residual properties of gases
5. To determine fugacity and activity
6. To determine activity coefficient
7. To determine thermodynamic properties of solution
8. To determine excess property of solution
9. To determine property changes of mixing of solution
10. To carry out flash calculation for binary system
11. To generate VLE data
12. To generate LLE data
13. To determine equilibrium constant for chemical reactions
14. Case Study of chemical plant

List of Course Projects:

1. Analysis of system containing pure fluids/solution.
2. Verification of experimental data
3. Bubble point and dew point calculation for binary system
4. Property changes of mixing
5. Flash calculations
6. Prediction of azeotrope formation
7. Analysis of phase equilibria
8. Analysis of chemical reaction equilibria
9. Determination of equilibrium conversion
10. Study of non-ideal solutions
11. Solid liquid equilibrium (SLE)
12. Solid vapor equilibrium (SVE).

List of Course Seminar Topics:

1. Evaluating thermodynamic properties of real fluids - a step ahead of ideal system
2. Fugacity - an interesting character in thermodynamics
3. Relevance of Property changes of mixing
4. Importance of chemical engineering thermodynamics in plant simulation
5. Usefulness of excess properties
6. Understanding interesting aspects of Entropy and its importance in thermodynamics
7. Chemical potential from different point of view
8. Fundamental property relations and its usage
9. Energy properties and its estimation - A perspective
10. Understanding Thermodynamic diagrams
11. Understanding Thermodynamic Cycles and Entropy
12. Importance of Residual properties in understanding Real Fluids
13. Applications of Chemical Engineering Thermodynamics
14. Understanding the concept of non-ideality
15. Gibbs Duhem Equations and their Utility

List of Home Assignments:

Blog

1. Importance of prediction on thermodynamic properties
2. Connect of chemical engineering thermodynamics to society
3. Chemical reaction equilibria in chemical industry
4. Phase equilibria - a perspective

Case Study

1. Simulation of chemical reaction equilibria
2. Activity coefficient models in thermodynamic packages
3. Techniques used for estimating the temperature of earth's interior
4. Effects of physical properties estimation on process design

Design Problem

1. Thermodynamic data for distillation column design
2. Thermodynamic data for reactor design
3. Thermodynamic data for overall plant design
4. Thermodynamic data for flash calculations

Survey

1. Chemical reactions confined within carbon nanotubes
2. Thermodynamic properties of aromatic hydrocarbon mixtures
3. Chemical reactions in sugar manufacturing
4. Thermodynamic properties of aliphatic hydrocarbon mixtures

Suggest an assessment Scheme:

Suggest an Assessment scheme that is best suited for the course. Ensure 360 degree assessment and check if it covers all aspects of Blooms Taxonomy.

ESE	*HA*	*CP*	*VIVA*	*SEM*
20	*20*	*20*	*20*	*20*

ESE - End Semester Examination
HA - Home Assignment
CP - Course Project
VIVA - Viva voice
SEM - Seminar

Text Books: ***(As per IEEE format)***

1. J. M. Smith, H. C. Van Ness, M. M. Abbott; Introduction to Chemical Engineering Thermodynamics; Seventh Edition, McGraw-Hill
2. K. V. Narayanan; A Textbook of Chemical Engineering Thermodynamics; Third Edition, Prentice-Hall of India Pvt. Ltd.

Reference Books: ***(As per IEEE format)***

1. B. G. Kyle; Chemical and Process Thermodynamics; Third Edition, Prentice Hall, New Jersey, 1999.
2. S. I. Sandler; Chemical and Engineering Thermodynamics; Third edition, John Wiley, New York, 1999.
3. O. A. Hougen, K. M. Watson, R. A. Ragatz; Chemical Process Principles Part II, Thermodynamics; John Wiley 1970
4. R. Reid, J. Praunitz, T. Sherwood; The Properties of Gases and Liquids; Third edition, McGraw-Hill, New York, 1977

Moocs Links and additional reading material: www.nptelvideos.in

Course Outcomes:

The student will be able to –

1. Estimate thermodynamic properties of pure substances in gas or liquid state
2. Estimate important thermodynamic properties of ideal and real mixtures of gases and liquids
3. Solve simple and complex chemical engineering problems using thermodynamic concepts, data and models
4. Apply criteria of phase equilibria for vapour liquid system and generate VLE data
5. Analyze phase equilibria involving vapor and/or liquid and/or solid
6. Analyze chemical reaction equilibria and use standard heats and free energies of formation to evaluate equilibrium constants and determine equilibrium

CO PO Map

CO/ PO	PO: 1	PO: 2	PO: 3	PO: 4	PO: 5	PO: 6	PO: 7	PO: 8	PO: 9	PO: 10	PO: 11	PO: 12	PSO :13	PSO :14
CO: 1	2	2	2	2	2	1	1	2	2	2	0	1	2	1
CO: 2	2	2	2	2	2	1	1	2	2	2	0	1	3	1
CO: 3	2	2	2	2	2	1	1	2	2	2	0	1	3	1
CO: 4	2	2	2	2	2	1	1	2	2	2	0	1	3	1
CO: 5	2	2	2	2	2	1	1	2	2	2	0	1	3	1
CO: 6	2	2	2	2	2	1	1	2	2	2	0	1	3	1

CO attainment levels

CO	Attainment level
CO:1	4
CO:2	4
CO:3	5
CO:4	5
CO:5	5
CO:6	5

Future Courses Mapping:
Mass Transfer, Chemical Reaction Engineering, Transport Phenomena

Job Mapping:
Core Chemical Engineering industrial job

Chemical Engineering Design job, Chemical Engg. research jobs

FF No. : 654

CH3237::MASS TRANSFER OPERATION

Course Prerequisites:

Course Objectives:

1. Apply principles of diffusion to separation and purification processes.
2. Select and design appropriate gas-liquid contacting devices
3. calculate mass transfer flux and estimate mass transfer coefficient and diffusivity for gas-liquid and liquid-liquid system
4. Performs mass transfer calculations for absorber, humidification and dehumidification and design cooling tower
5. Calculate rate of drying and select proper dryer, and find batch time for batch drier and design rotary drier for given requirement
6. Comprehend the fundamentals of the crystallization system.

Credits:4 **Teaching Scheme Theory:2** Hours/Week

Tut:1 Hours/Week

Lab: 2 Hours/Week

Course Relevance:

SECTION-1
Introduction to Mass Transfer and Molecular Diffusion: Introduction to Mass Transfer Operations. Molecular Diffusion in gases and liquids, diffusivities of gases and liquids, types of diffusion, Fick's and Maxwell law of diffusion, Measurement of liquid-phase diffusion coefficient, Concept of diffusivity, diffusivity of liquids, Eddy diffusion, film theory, penetration theory, surface renewal theory, Steady state diffusion. mass transfer coefficients, Mass, heat and momentum transfer analogies. ; Interphase mass transfer, local two phase mass transfer, overall mass-transfer coefficient, average overall coefficient, steady state co-current and countercurrent processes, Continuous co- current and counter current processes, cascades, batch processes, Stages and mass transfer rates. Gas- liquid operations and Equipment for Mass Transfer, Overall mass transfer coefficient, Gas dispersal equipments – bubble columns, Liquid dispersal equipments – Venturi scrubbers, wetted wall columns. Gas dispersed Sparged vessels – flow of gas velocity problems based on aeration tank as a time for sparging Gas hold up. Liquid hold up – determination of interfacial area based on hold up and MTC. Tray tower versus packed tower

SECTION-1I

Gas Absorption: Mechanism of gas absorption, equilibrium in gas absorption, choice of solvent, Countercurrent multistage operation, Non-isothermal operation, absorption in wetted wall columns, values of transfer coefficient, absorption in packed tower and spray tower, calculation of HETP, HTU, NTU, calculation of height of packed and spray tower. Absorption in tray towers, absorption and stripping factors, calculation of number of trays for absorption Tray efficiencies, absorption with chemical reaction. ; Humidification, Dehumidification Principles, vapour-liquid equilibria, enthalpy of pure substances, wet bulb temperature relation, Lewis relation, Psychrometric chart, methods of humidification and dehumidification, cooling tower design – HTU, NTU concept, calculation of height of cooling tower.; Drying and Liquid-liquid extraction: Principles, equilibrium in drying, type of moisture binding, mechanism of batch drying, continuous drying, time required for drying, mechanism of moisture movement in solid, Design principles of tray dryer, rotary dryer, spray dryer. Spray dryer, fluidized bed and spouted bed dryer, pneumatic dryer and vacuum dryer. Crystallisation- Theory and design.

List of Practicals: (Any Six)

1. Study diffusion of liquid into a gas in a vertical pipe and calculate mass transfer coefficient.
2. Study steady state diffusion of acetone in air and calculate diffusivity.
3. To study characteristics of tray dryer and calculate rate of drying.
4. To study steady state molecular diffusion of acetic acid through water and determine diffusivity.
5. To determine efficiency of rotary dryer.
6. To study characteristics of cooling tower for efficiency and relative cooling.
7. To calculate mass transfer coefficient for absorption of CO2 into NaOH solution.
8. To calculate mass transfer coefficient for absorption of CO2 into water.
9. To determine mass transfer coefficient for air-water system during humidification and de- humidification process.
10. To study crystallization to find yield.
11. Study diffusion of solid into a liquid and calculate mass transfer coefficient
12. Any two experiments from above syllabus using virtual lab.

List of Course Projects:

1. Design of tray dryer
2. Design of rotary dryer
3. Design of plate column stripper
4. Design of packed column stripper
5. Design of tray tower absorber
6. Design of packed tower absorber
7. Design of cooling tower
8. Design of batch crystallizer
9. Design of forced circulation crystallizer
10. Data analysis of diffusion of solid into liquid
11. Data analysis of diffusion of liquid into gas
12. Data analysis of diffusion of liquid into liquid

List of Course Group Discussion Topics:

1. Mass Transfer essential part over heat transfer in given process
2. Molecular verses convective diffusion
3. Interphase mass transfer key study for 2 or more phases and component system
4. Mass Transfer coefficient important to decide efficacy of process
5. Absorber crucial part for environment verses economy of process
6. Is mass transfer consideration crucial for nuclear system
7. Is mass transfer crucial for pharmaceutical industry
8. Selection appropriate dryer for low moisture content process
9. Selection of appropriate dryer for high moisture content product
10. Selection of crystalliser for low solid content magma
11. Selection of crystalliser for high solid content in magma
12. Operating window for distillation column
13. Operating window for absorber
14. Mass transfer in microchannels
15. Mass transfer in nanofluids

List of Home Assignments:

Design:

1. Design of absorber
2. Design of interphase mass transfer equipment
3. Design of Crystalliser
4. Design of dryer
5. Designing mass transfer system for one diffusing and other non-diffusing component
6. Designing mass transfer system for counter diffusing components
7. Deciding mass transfer coefficient for efficient system

Case Study:

1. Case study of interphase mass transfer system
2. Case study on dryer
3. Case study on absorber
4. Case study on crystalliser
5. Case study on diffusion process

Blog

1. Molecular diffusion and convective diffusion efficacy
2. Interphase mass transfer key parameter to gauge efficacy of process
3. Absorber effective medium for reducing pollution
4. Drying crucial for preservation of substance
5. Crystalliser important for pure product

Surveys

1. Mass transfer in pharmaceutical industry
2. Role of interphase mass transfer in Petroleum industry
3. Humidity monitor crucial in drying process.
4. Efficient dryer for multipurpose.
5. 5. Versatile crystalliser

Suggest an assessment Scheme:

Suggest an Assessment scheme that is best suited for the course. Ensure 360 degree assessment and check if it covers all aspects of Blooms Taxonomy.

ESE	*HA*	*CP*	*VIVA*	*GD*
20	*20*	*20*	*20*	*20*

ESE - End Semester Examination
HA - Home Assignment
CP - Course Project
VIVA - Viva voice
GD - Group Discussion

Text Books: ***(As per IEEE format)***

1. Robert Trybal, Mass Transfer operation, Edition 5, Mcgraw hill publication
2. B. K. Datta, Principle of mass transfer, Edition, PHI Learning publication, 2015

Reference Books: ***(As per IEEE format)***

1. Perry R. H., Green D. W.; Perry's Chemical Engineer's Handbook; Sixth Edition, McGraw-Hill, 1984
2. Coulson J. M.; Richardson, J. F.; Chemical Engineering – Vol. I & II; 6 th Edition, Butterworth- Heinemann.

Moocs Links and additional reading material: www.nptelvideos.in

Course Outcomes:

The student will be able to –

1. Apply principles of diffusion to separation and purification processes and calculate mass transfer flux and estimate mass transfer coefficient and diffusivity for gas-liquid and liquid-liquid system
2. Select and design appropriate gas-liquid contacting devices
3. Select and design gas absorption and stripping column
4. Calculate mass transfer coefficient for humidification and dehumidification and design cooling tower
5. Calculate rate of drying and select proper dryer, and find batch time for batch drier and design rotary drier for given requirement
6. Comprehend crystallization system and fundamental of design

CO PO Map

CO/ PO	PO: 1	PO: 2	PO: 3	PO: 4	PO: 5	PO: 6	PO: 7	PO: 8	PO: 9	PO: 10	PO: 11	PO: 12	PSO :13	PSO :14
CO: 1	2	2	2	2	2	1	1	2	2	2	0	1	2	1

CO: 2	2	2	2	2	2	1	1	2	2	2	0	1	3	1
CO: 3	2	2	2	2	2	1	1	2	2	2	0	1	3	1
CO: 4	2	2	2	2	2	1	1	2	2	2	0	1	3	1
CO: 5	2	2	2	2	2	1	1	2	2	2	0	1	3	1
CO: 6	2	2	2	2	2	1	1	2	2	2	0	1	3	1

CO attainment levels

CO	Attainment level
CO:1	4
CO:2	4
CO:3	4
CO:4	5
CO:5	5
CO:6	5

Future Courses Mapping:

Separation Techniques, Chemical Reaction Engineering, Transport Phenomena

Job Mapping:
Core Chemical Engineering industrial job

FF No. : 654

CH3235::CHEMICAL REACTION KINETICS

Course Prerequisites: Knowledge of basics of chemistry and mathematics

Course Objectives:

1. To study chemical reaction kinetics of homogeneous reactions
2. To study different types of chemical reactors used in industries
3. To learn design of reactors used for homogeneous reactions
4. To study multiple reactor system and their selection
5. To optimize the parameters like temperature and pressure for reactions

Credits:4

Teaching Scheme Theory:2 Hours/Week
Tut:1 Hours/Week
Lab: 2 Hours/Week

Course Relevance:

SECTION-1
Homogeneous reaction kinetics and design of Ideal reactors   Elementary and non elementary reactions, Stoichiometry, Fractional conversion,, Law of mass action, Rate Constant-Based on thermodynamic activity, partial pressure, mole fraction and concentration of the reaction components and their interrelation, Temperature dependency of rate Constant - Arrhenius law, Transition state theory and collision theory. Batch reactor concept- Constant volume Batch reactor system; Design equation for zero, first, Second irreversible and reversible reactions, graphical interpretation of these equations and their limitations, Variable volume Batch reactors. Design equation for first and second order irreversible and reversible reactions, graphical interpretation of their limitations, Multiple reactions- Stoichiometry and rate equations for series and parallel reactions, Ideal reactors-Concept of ideality, Types of flow reactors and their differences, Design equations for ideal reactor
SECTION-1I

Multiple reactor systems and Temperature and Pressure Effects

Multiple reactor systems- Size comparison of reactors, Optimum size determination, Staging of reactors, Flow reactors in series and parallel, Performance of infinite number of back mix reactors in series, Back mix and plug flow reactors of different sizes in series and their optimum way of staging; Recycle reactors- Optimum recycle ratio for auto-catalytic (recycle) reactors ,Yield and selectivity, Parallel reactions, best operating conditions for mixed and plug flow reactors, irreversible Series reactions, Effect of temperature and pressure- Equilibrium Conversion, Optimum temperature progression, Isothermal, Adiabatic and non isothermal operations, Temperature and conversion profiles for exothermic and endothermic reactions

List of Practicals: (Any Six)

1. To calculate value of rate constant ‘k’ for the saponification of ethyl acetate with NaOH in batch reactor – I (Where M=1)
2. To calculate value of rate constant ‘k’ for the saponification of ethyl acetate with NaOH in straight tube, coli Bent Tube reactor and PFR
3. To calculate the value of rate constant ‘k’ for the saponification of ethyl acetate with NaOH in a mixed flow reactor.
4. Verification of Arrhenius law
5. Semi batch Reactor Addition of NaOH in Ethyl acetate, Utilization of **POLYMATH** for finding behavior of products with respective of time.
6. Study the effect of various combinations of reactors on conversion
7. Non linear regression in **POLYMATH** to get kinetic parameters
8. To generate the temperature-conversion profile for an adiabatic reaction in a CSTR
9. To generate the temperature-conversion profile for an adiabatic reaction in a PFR
10. To determine optimum residence time for multiple parallel reactions
11. Design of a CSTR using DWSIM software
12. Design of a PFR using DWSIM software

List of Course Projects:

1. Utilization of POLYMATHS for finding behavior of products with respective to time in reactors
2. Effect of reactor types on product distribution for multiple reactions.
3. To generate temperature conversion profiles for exothermic and endothermic reactions
4. Design and simulation using ASPEN/CAPE OPEN of isothermal plug / mixed flow reactor/
5. Design and simulation using ASPEN of non- isothermal mixed flow reactor
6. Design of recycle reactor using ASPEN software
7. Generate temperature conversion profile for adiabatic plug /CSTR flow reactor
8. Study of product distribution for series reactions in plug flow reactor
9. Study of product distribution for parallel reactions in plug flow reactor
10. 10 Finding tau optimum using POLYMATH for multiple reactions
11. Study of product distribution for series (B)/ parallel (A) reactions in mixed flow reactor
12. Determination of the reaction kinetics for multiple reactions
13. 13.Design of Batch reactor using DWSIM software
14. 14.Design of a CSTR using DWSIM or CAPE OPN software
15. 15.Design of a PFR using DWSIM software

List of Course Seminar Topics:

1. Reaction mechanism to generate rate laws for homogeneous reactions
2. Different methods interpret batch reactor data to generate rate laws
3. Multiple reactor system
4. Flow reactors used in chemical industries
5. Polymerisation processes
6. Nuclear Reactor
7. Bio reactor
8. Micro reactors, design and applications
9. Plastic waste management
10. Process intensification
11. Recycling of plastic
12. Nano particles and its application
13. Waste water treatment methods
14. Potable water from waste water
15. Temperature control in exothermic and endothermic reactions

List of Home Assignments:

Design:

1. Design of isothermal Plug flow reactor and simulation using ASPEN Software
2. Design of non isothermal Continuous stirred tank reactor simulation using ASPEN Software
3. Design of isothermal stirred tank reactors in series simulation using ASPEN Software
4. Design and comparison of CSTR and PFR

Case Study:

1. Determination of detailed kinetics of a catalytic reaction
2. CO2 Chemisorption process
3. Carbon capture methods
4. Parallel Reactions in plug flow reactors

Blog

1. Hydrogen from biomass
2. Novel reactors in chemical industries
3. Application of oxidation methods in wastewater treatment
4. Difficulties in scale up of nano materials.

Surveys

1. Kinetic study of homogeneous reactions
2. Various Polymer industries in india and types of polymers
3. Fertilizer industries in india and it's future scope
4. Pulp and paper industries in India and it's future scope

Suggest an assessment Scheme:

Suggest an Assessment scheme that is best suited for the course. Ensure 360 degree assessment and check if it covers all aspects of Blooms Taxonomy.

ESE	*HA*	*CP*	*VIVA*	*SEM*
20	*20*	*20*	*20*	*20*

ESE - End Semester Examination
HA - Home Assignment
CP - Course Project
VIVA - Viva voice
SEM - Seminar

Text Books: ***(As per IEEE format)***

1. Octave Levenspiel,, 'Chemical Reaction Engineering', 3rd. edition, John Wiley& Sons, 2001.
2. Fogler, H. S., 'Elements of Chemical Reaction Engineering', 3rd Ed., PHI, 2002.

Reference Books: *(As per IEEE format)*

1. Walas, S. M., 'Reaction Kinetics for Chemical Engineers', McGraw Hill, 1959.
2. Smith, J.M., 'Chemical Engineering Kinetics', 3rd ed., McGraw Hill, 1987.

Moocs Links and additional reading material:
NPTEL :: Chemical Engineering - NOC:Chemical Reaction Engineering-I

Course Outcomes:

The student will be able to –

1. Develop rate expressions from elementary and non elementary step mechanisms using steady-state and quasi-equilibrium approximations.
2. Determine rate expressions by analyzing reactor data including integral and differential analysis on constant and variable volume systems
3. Design ideal reactors i.e. plug flow and CSTR for first and second order reversible and irreversible, constant and variable volume systems.
4. Select and size isothermal reactors for multiple reaction system and determine product distribution
5. Quantitatively predict the performance of common chemical reactors in various combinations
6. Generate temperature and conversion profiles for exothermic and endothermic reactions

CO PO Map

CO/ PO	PO: 1	PO: 2	PO: 3	PO: 4	PO: 5	PO: 6	PO: 7	PO: 8	PO: 9	PO: 10	PO: 11	PO: 12	PSO :13	PSO :14
CO: 1	3	2	1	2	3	2	2	2	2	1	1	1	2	1
CO: 2	3	2	1	2	3	2	2	2	2	2	2	2	2	2
CO: 3	3	2	2	2	3	2	2	2	2	2	2	2	2	2
CO: 4	3	2	2	2	3	2	2	2	2	2	2	2	3	3
CO: 5	3	3	3	2	3	2	2	2	2	2	2	2	3	3
CO: 6	3	2	2	2	3	2	2	2	2	2	2	2	3	3

CO attainment levels

CO	Attainment level
CO:1	2
CO:2	2
CO:3	4
CO:4	5
CO:5	5
CO:6	5

Future Courses Mapping: Chemical Reaction Engineering, Bioengineering etc.

Job Mapping: Chemical, Petroleum, Petrochemical Industries, Biochemical Industries etc.

CH3287::ENGINEERING DESIGN AND INNOVATION V

Course Prerequisites: Basic principles of physics, mathematics, chemistry, heat transfer

Course Objectives:

The students will be able to

1. Do literature search appropriately with available tools
2. Defining of project title/idea
3. Allocation of tasks among the team members
4. Team spirit development
5. Write a report, research paper with required format
6. Present work effectively with concrete results

Credits: 04 **Teaching Scheme Theory: …..** Hours/Week

Tut: …….. Hours/Week

Lab: **08** Hours/Week

Course Relevance: Engineering Design and development is specially design part of curriculum, that will facilitate application of theory concept in practice. This is project based learning experience. As in practical situation, where first project is defined and then respective required skilled are learned to accomplish the project. We are making student ready to face and approach actual problem.

SECTION-1&II
Topics and Contents *This stage will include a complete report consisting of synopsis, the summary of the literature survey carried out, Details of experimental/theoretical work and results and discussion and conclusion.* *Students may undertake studies in application chemical engineering knowledge for manufacturing project, synthesis, design and development, experimental work, testing on the product or system, generation of new ideas and concept, modification in the existing process/system, development of computer programs, solutions, modeling and simulation related to the subject. Topics of interdisciplinary nature may also be taken up. A detailed literature survey is expected to be carried out as*

a part of this work. The group of students is required to choose the topic in consultation with the Guide.

A technical report of 15 pages is required to be submitted at the end of the term and a presentation made based on the same. Modern audio-visual techniques may be used at the time of presentation.
The external from Industry/research organization is invited to evaluate the projects done by students.

List of Project areas:

1. Agriculture
2. Personal Health
3. Social health
4. Hygiene
5. Energy
6. Environment
7. 7.Potable Water
8. Solar based
9. Modeling and Simulation
10. Waste water treatment
11. Air pollution
12. Solid waste management
13. Low-cost product development

Suggest an assessment Scheme:

Assessment of Engineering Design and Innovation project includes three reviews spread across 4 months, where research innovative ideas, strategy of execution, actual execution, teamwork is assessed.

Every review is based on report writing, presentation of results and team work demonstration.

Two reviews are with internal faculty members
Third review is with an external industry expert.

Review 1: Literature search and deciding appropriate topic
Review 2: Progress of work on decided topic i.e setting experimental setup, developing methodology of solving the opted problem.
Review 3: Overall assessment of project work with team efforts.

Moocs Links and additional reading material: www.nptelvideos.in

1. https://nptel.ac.in/courses/103/103/103103039/#watch
2. https://www.honeywellprocess.com/en-US/explore/solutions/integrated-technology/Pages/leap.aspx
3. https://www.gtu.ac.in/uploads/GIC%20Compendium%20IDP-UDP.pdf
4. https://www.udemy.com/course/leadership-psychology-cultivate-creativity-and-innovation/
5. https://www.coursera.org/learn/uva-darden-project-management
6. https://www.coursera.org/specializations/innovation-creativity-entrepreneurship

Course Outcomes: The student will be able to –

1. Apply chemical engineering knowledge.
2. Learn how to work in a team.
3. Define a task (problem) and execute it.
4. Carry out literature search related to topic.
5. Write synopsis and complete literature search related to topic and complete report.
6. Present the outcome of work systematically in a team.

CO PO Map

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14
CO1	3	1	1	1	0	1	1	1	1	1	1	1	1	1
CO2	0	0	0	0	0	0	0	2	3	1	3	1	0	0
CO3	3	1	1	1	1	1	1	1	1	1	1	1	1	1
CO4	1	3	1	1	1	1	1	1	1	1	1	1	1	1
CO5	1	1	1	1	1	1	1	1	1	3	1	1	1	1
CO6	1	1	1	1	1	1	1	1	1	2	1	1	1	1

CO attainment levels

CO	Attainment level
1	2

2	**3**
3	**3**
4	**5**
5	**5**
6	**4**

Future Courses Mapping:

Next semester project, BTech course project

Job Mapping:
What are the Job opportunities that one can get after learning this course
Core Chemical Engineering industrial job
Chemical Engineering Design job
Chemical Engg. research jobs

FF No. : 654

CH3291::DESIGN THINKING 1

Course Prerequisites: Basic principles of science

Course Objectives:

To provide ecosystem for paper publication and patent filing

Credits: 01 **Teaching Scheme** **Tut:** **1** Hours/Week

Course Relevance: To assist for publication of research paper or patent

SECTION-1&II
Topics and Contents *Students may undertake studies in application chemical engineering knowledge for manufacturing project, synthesis, design and development, experimental work, testing on the product or system, generation of new ideas and concept, modification in the existing process/system, development of computer programs, solutions, modeling and simulation related to the subject. Topics of interdisciplinary nature may also be taken up. A detailed literature survey is expected to be carried out as a part of this work. The group of students is required to choose the topic in consultation with the Guide.* *A paper/patent is required to be published at the end of the term and a presentation made based on the same. Modern audio-visual techniques may be used at the time of presentation.* *The external from Industry/research organization is invited to evaluate the projects done by students.*

List of Project areas:

1. Agriculture
2. Personal Health
3. Social health
4. Hygiene
5. Energy
6. Environment
7. Potable Water
8. Solar based
9. Modeling and Simulation
10. Waste water treatment
11. Air pollution
12. Solid waste management
13. Low-cost product development

Suggest an assessment Scheme:

It is based on type of publication

Moocs Links and additional reading material: www.nptelvideos.in

Course Outcomes: The student will be able to –

1. Understand the importance of doing Research
2. Interpret and distinguish different fundamental terms related to
3. Research
4. Apply the methodology of doing research and mode of its
5. publication
3. Write a Research Paper based on project work
4. Understand Intellectual property rights
5. Use the concepts of Ethics in Research
6. Understand the Entrepreneurship and Business Planning

CO PO Map

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14
CO1	1	1	1	1	1	0	0	0	0	0	0	1	1	1
CO2	1	1	1	1	1	0	0	0	0	0	0	1	1	1
CO3	2	2	3	3	2	2	1	2	2	3	0	1	1	1
CO4	3	3	3	3	3	2	1	2	2	3	1	1	1	1
CO5	1	1	1	1	1	0	0	0	0	0	0	1	0	0
CO6	2	2	2	2	2	2	1	3	2	3	0	1	0	0
CO7	1	1	1	1	1	0	0	0	0	0	0	1	0	0

CO attainment levels

CO	Attainment level
1	2
2	2
3	3
4	5
5	2
6	3
7	2

Future Courses Mapping:

Next semester project, BTech course project

Job Mapping:

What are the Job opportunities that one can get after learning this course
Core Chemical Engineering industrial job
Chemical Engineering Design job
Chemical Engg. research jobs

FF No. : 654

CH3232::INSTRUMENTATION AND PROCESS CONTROL

Course Prerequisites: None

Course Objectives:

1. To understand the methodology of dynamic modeling
2. To understand the notion of feedback control
3. To understand the operation of a PID controller
4. To be able to carry out controller design using various time-domain and frequency domain techniques
5. To understand advanced process control schemes used in industry.

Credits: 4 **Teaching Scheme Theory: 2** Hours/Week

Tut: 1 Hours/Week

Lab: 2**.** Hours/Week

Course Relevance: This subject deals with control of industrial systems and so is of vital importance. With this subject the students will get an understanding of dynamic behavior of processes. The key notion of control of a process at the desired operating point is addressed in this course. With a number of theoretical and practical controller design tools covered in the course, the students will get a thorough exposure to this important area of industrial process control.

SECTION-1
Instrumentation, Process Dynamics, Feedback Control *Instrumentation: Measurement fundamentals. Temperature, flow, pressure, level and composition measuring instruments. Static and dynamic characteristics. Control valves: sizing and valve characteristics* *Process Dynamics: Introduction to process control. Review of Laplace transforms. Development of mathematical and dynamic models of chemical engineering systems. First order, second order systems. Systems with time delays. Interacting & non-interacting processes.* *Feedback control: Block diagram. PID controller. Typical time-domain responses of feedback control systems. Servo and regulatory problems.*

SECTION-1I

Control System Design, Advanced Process Control

Stability Analysis: Stability analysis of closed-loop control systems. Routh stability criterion. Root locus. Bode stability analysis. Design of feedback control systems using time-domain and frequency-domain techniques. Controller tuning methods such as Ziegler-Nichols.

Advanced Process Control: Feedforward control, cascade control, etc. Introduction to digital control.

Overview of data science techniques relevant to industrial process control.

List of Practicals: (Any Six)

1. Measurements for temperature, pressure, flow, level etc
2. Interacting and non-interacting systems
3. Process identification: First order plus dead time system
4. P controlled system
5. PI controlled system
6. PID controlled system
7. Root locus-based controller design using a software tool such as Scilab
8. Bode analysis-based controller design using a software tool such as Scilab
9. Dynamic simulation of simple systems such as liquid level on a chemical engineering simulation software
10. Dynamic simulation of a distillation column

List of Projects:

1. Controller tuning
2. P&ID diagrams for flow sheets
3. design a control system using time-domain techniques such as root-locus
4. design a control system using frequency-domain techniques such as Bode design
5. Dynamic behaviour of pure capacity process
6. Feedback control system design using Scilab/Octave/Matlab/Python etc
7. Dynamic simulation of a distillation column
8. Dynamic simulation of a chemical plant flowsheet
9. Data science techniques in chemical process control
10. Feedforward control / Cascade control / Selective control / Multiloop and multivariable control

List of Course Group Discussion Topics:

1. Variable head flow meters
2. Variable pressure flow meters
3. PID Controller tuning
4. Root locus and controller design
5. Bode plot and controller design
6. Level control
7. Flow control
8. Process control in paper industry
9. Distillation column control
10. Boiler control

List of Home Assignments:

Design:

1. PID controller tuning using Root locus
2. PID Controller tuning using Bode plot
3. PID controller tuning using Ziegler-Nichols open loop method
4. PID Controller tuning using Cohen-Coon method
5. Digital PID controller implementation with anti-reset windup & derivative overrun compensation

Case Study:

1. Control of highly nonlinear processes
2. Use of nanotechnology in process instrumentation
3. Big data analytics in chemical industry
4. BASF Verbund
5. Machine learning in chemical industry

Blog

1. Internet of Things in Chemical Industry
2. Batch process control
3. Advanced process control in chemical industry
4. Process control in plant-on-chip systems
5. Deep learning in chemical industry

Surveys

1. Real time optimization (RTO) systems
2. Sustainability through process control
3. On-line analyzers in chemical industry
4. Batch process control
5. Statistical process control

Suggest an assessment Scheme:

ESE	*HA*	*CP*	*VIVA*	*GD*
20	*20*	*20*	*20*	*20*

ESE - End Semester Examination

HA - Home Assignment

CP - Course Project

VIVA - Viva voice

GD - Group Discussion

Text Books: ***(As per IEEE format)***

1. D. R. Coughanowr, "Process Systems Analysis and Control", 2nd ed. McGraw-Hill, 1991.
2. B. C. Nakra and K. K. Chaudhry, "Instrumentation, Measurement and Analysis", 2nd ed. Tata McGraw-Hill, 2004.

Reference Books: ***(As per IEEE format)***

1. D. E. Seborg, T. F. Edgar and D. A. Mellichamp, "Process Dynamics and Control", 2nd ed. John Wiley & Sons, 2004.

Moocs Links and additional reading material:

1. P. Saha, "Process Control and Instrumentation", IIT Guwahati, NPTEL. [Online]. Available: https://nptel.ac.in/courses/103/103/103103037/
2. S. S. Jogwar, "Chemical Process Control", IIT Bombay, NPTEL. [Online]. Available:https://nptel.ac.in/courses/103/105/103105064/
3. B. S. Johnson, "Process Dynamics, Operations and Cotrol", MIT OPENCOURSEWARE, MIT. [Online] Available: https://ocw.mit.edu/courses/chemical-engineering/10-450-process-dynamics-operations-and-control-spring-2006/

Course Outcomes:

The student will be able to –

1. carry out selection and performance analysis of measuring instruments
2. write dynamic models of chemical engineering systems
3. carry out process identification and tune a PID controlled system
4. design a control system using time-domain techniques such as root-locus
5. design a control system using frequency-domain techniques such as Bode design
6. carry out preliminary analysis of Advanced Process Control systems

CO PO Map

CO/ PO	PO: 1	PO: 2	PO: 3	PO: 4	PO: 5	PO: 6	PO: 7	PO: 8	PO: 9	PO: 10	PO: 11	PO: 12	PSO : 13	PSO : 14

CO1	2	1										1	1	
CO2	2	1	2	1	2					1		1	1	
CO3	2	1	3	3	2				1	1		1	1	
CO4	2	1	3	1	2				1	1		1	1	
CO5	2	1	2	1	2				1	1		1	1	
CO6	2	1	2	1								1	1	

CO attainment levels

CO	Attainment Level
1	3
2	5
3	5
4	5
5	5
6	3

Future Courses Mapping:

None

Job Mapping:

1. *Industries providing control system solutions*
2. *Industries providing chemical process simulation services, OTS etc*
3. *Postgraduate education*

FF No. : 654

CH3234::PROCESS EQUIPMENT DESIGN

Course Prerequisites: Basics of heat transfer and materials

Course Objectives:

1. To Understand design the heat exchanger
2. To Comprehend design of hydraulic plate design
3. To Understand the material standards for design
4. To Comprehend axillary equipment
5. To Understand mixing vessel details

Credits:04 **Teaching Scheme Theory: 02 Hours/Week**

Tut: 01 Hours/Week

Lab: 02 Hours/Week

Course Relevance:

Process equipment design is of vital importance for industrial design. It covers important design of heat exchange that is crucial for heat recovery or heat transfer in industry. Agitator vessel design is another crucial part for chemical industry. Plate and pack column comprehension is very much part of every chemical industry. Auxiliary equipment study completes remaining part of any process industry.

Introduction to Course outcome and assessment: 2 hr

a. Explanation of Course outcomes

b. Explanation of Course outcome to assessment mapping.

SECTION-1
Topics and Contents 14 hr *Heat Exchangers: Introduction, process heat transfer, types of heat exchangers, codes and standards for heat exchangers, materials of construction, API scale, LMTD, countercurrent & concurrent exchangers, temperature approach & cross, counter-flow: double pipe exchangers, baffles and tie rods, design of shell and tube heat exchangers as per IS: 4503 and TEMA standards i.e. shell, tube sheets, channel, channel cover, flanged joints. Design of Double pipe, plate type heat exchangers. Joints, bearings, drives, mechanical seals, fabrication methods. Evaporators & pressure vessels: Classification of vaporizing equipment, evaporators (including different types such as kettle, thermosiphon, vertical, horizontal etc. Chemical evaporators, natural circulation & forced circulation evaporators, the calculation of chemical evaporators. Types of pressure vessels, codes and standards for pressure vessels (ASME Sec VIII Div-1, 2), material of construction, selection of material, selection of corrosion allowance and weld joint efficiency, purging of vessels. selection and design of various heads such as flat, torispherical, elliptical, hemispherical and conical. Opening/ nozzles and manholes, nozzle sizing, calculations etc. Condenser design for condensation of single vapors, Design of total and partial condenser with pressure balance. Vertical condenser, horizontal condenser. Allowable pressure drop in condensers, condenser-subcooler, condensation of steam- surface condenser. jacket for vessels. Introduction and classification of supports, design of bracket or lug supports, saddle support*
SECTION-1I

Topics and Contents	14 hr
Mass transfer equipment with storage vessel and mixer consideration: Tray column design and storage vessels: Design of plate column- distillation columns, design variables in distillation, design methods for binary systems, plate efficiency, approximate column sizing, plate contactors, plate hydraulic design. Various types of storage vessels and applications, losses in storage vessels, storage of fluids- storage of volatile & non-volatile liquids- fixed roof and variable volume tanks, Packed Column Design and mixers: Choices of packing, types of packing, packed bed height (distillation and absorption), HETP, HTU, NTU, Cornell's method, Onda's method, column diameter, column internals, column auxiliaries. Mixers- Various types of mechanical mixers- propeller, turbines & paddles their selection, flow patterns in agitated tanks, baffling, design practices, standard geometry tank, power dissipation and discharge flow correlation, mechanical agitator design. Reaction vessels. Filters, Dryers and auxillary process vessels : Study of various types of filters like vacuum filters, pressure filters, centrifuges and rotary drum filters, design of rotary drum filters including design of drum, shaft, bearing and drive system. Types of dryers, batch type dryers, continuous dryers. Study of auxiliary process vessels such as reflux drum, knockout drum, liquid-liquid and gas-liquid separators, entrainment separators, oil water separator, Decanter, gravity separator.	

List of Practicals: (Any Six)

1. Design of Shell and Tube heat exchanger.
2. Design of double pipe heat exchanger
3. Design of vaporiser
4. Design of condenser
5. Design of distillation column
6. Design of types of supports for vessels
7. Design of various types of heads for vessels
8. Design of agitators for chemical reactors
9. Literature survey on types of safety valves, safety devices for chemical equipments
10. Autocad drawing of tubes sheet for the Shell and tube heat exchanger.
11. Economic analysis for Shell and tube heat exchanger.
12. Economic analysis for Shell and tube heat exchanger.

List of Course Projects:

Every project will consist of Process flow diagram, Process Utility diagram, Piping and Instrumentation diagram, Material balance, heat balance, heat exchanger, reactor, distillation column design for given flowsheet for Chemical manufacturing.

1. Manufacturing of Sulfuric acid
2. Manufacturing of Hydrochloric acid
3. Manufacturing of Nitric acid
4. Manufacturing of salicylic acid
5. Manufacture of toluene
6. Manufacturing of caprolactum
7. Manufacturing of phenol
8. Manufacturing of cyclohexane
9. Manufacturing of cumene
10. Synthesis gas by steam methane reforming
11. Manufacturing of ammonia
12. Manufacturing of Soda Ash
13. Manufacturing of Caustic soda
14. Manufacturing of Acetone
15. Manufacturing of Ethanol
16. Manufacturing of Butanol
17. Manufacturing of Methanol
18. Manufacturing of Pentane
19. Manufacturing of hexane
20. Manufacturing of Heptane
21. Manufacturing of Benzoic Acid
22. Manufacturing of MTBE
23. Manufacturing of Butylene
24. Design of multi-effect evaporator.
25. Design of extractive distillation system
26. Design of extractive distillation system
27. Design of liquid-liquid separator.
28. Design of liquid-liquid separator.

List of Course Group Discussion Topics:

1. Advances in heat exchanger design
2. Best heat exchanger for corrosive fluids handled
3. Best heat exchanger for petroleum product cooling or heating
4. National, international material codes for design
5. Distillation plate vs packed column
6. Best Evaporators for industry i.e Chemical, forced, natural circulation
7. overall heat transfer, velocity, pressure drop, dirt factor balance
8. Necessity of heat exchange in process industry
9. Necessity of heat exchange in daily life
10. re-Boilers in chemical industry
11. Condensers in Process industry
12. Dryers in process industry
13. Agitators for process industry
14. Best suitable cooling tower for process industry
15. Role of materials in Heat exchanger design

List of Home Assignments:

Design:

1. Design heat exchanger to cool crude oil available at 50000 kg/hr flowrate from 110 0C to 50 0C.
2. Design plate type distillation column to recover 99% ethanol from 50% ethanol water feed available at 20000 kg/hr flow rate
3. Design efficient agitator for absorption of CO_2 in K_2CO_3 solution
4. Design multiple efficient evaporator for concentration of sugar syrup from 15% to 45% with flowrate of 35000 kg/hr of feed
5. Design of distillation column for separation of ethanol water system for handling 10000 kg/hr of 50% Ethanol in feed, giving 99% purity at top.

Case Study:

1. Heat exchanger used for heat recovery in Chemical process industry
2. Plate type heat exchanger
3. Tray column
4. Packed column
5. Auxillary equipments

Blog

1. Smart heat exchangers for 21st centry
2. Distillation boon for chemical industry
3. Codes, standards: Best safety aspect of industry
4. 4.Separators bottleneck of chemical industry
5. Valves selection for industry

Surveys

1. Recent advances in heat exchanger
2. Advancement in plate type column

3. Pack column efficient way for enrichment of compound
4. Most efficient Agitator for process industry
5. Best accessory stream for process industry

Assessment Scheme:

ESE	*HA*	*CP*	*VIVA*	*GD*
20	*20*	*20*	*20*	*20*

ESE - End Semester Examination

HA - Home Assignment

CP - Course Project

VIVA - Viva voice

GD - Group Discussion

Text Books: ***(As per IEEE format)***

1. D. Q. Kern;Process Heat Transfer; Tata McGraw Hill Publications, 2009
2. R. K. Sinnott; Coulson & Richardson’s Chemical Engineering, Volume-6; Elsevier Butterworth Heinemann, MA, 2005.
3. V.V. Mahajani, S. B. Umarji; Joshi's Process Equipment Design; 5th Edition; Trinity Press
4. Lloyd E. Brownell, Edwin H. Young; Process Equipment Design; 1st Edition; Wiley-Interscience

Reference Books: ***(As per IEEE format)***

1. Walas, S. M; Chemical process equipment: selection and design; Butterworth-Heinemann, 1990.
2. Ludwig, E.E.; Applied Process Design for Chemical and Petrochemical Plants, Vol. 1 and 2; 3rd Ed.; Gulf Publishing Co., 1997.
3. Eugene F. Megyesy; Pressure Vessel Handbook; 10th Edition; Pressure Vessel Publishing, INC.
4. R. K. Sinnott; Coulson and Richardson's Chemical Engineering Volume 6 - Chemical Engineering Design; 4th Edition; Pergamon Press.

Moocs Links and additional reading material: www.nptelvideos.in

Course Outcomes:

1. Carry out the detailed thermal design of double pipe and shell and tube heat exchanger for given requirement
2. Design a multiple effect evaporation system for specific requirement of concentration
3. Do hydraulic plate design and tray column design for desired separation needs
4. Select type and size of packing and packed column design with internals for required separation
5. Select and design support for vessels
6. 6 Choose and design auxiliary process equipment required for various simple separation & storage requirements

CO PO Map

CO/ PO	PO:1	PO:2	PO:3	PO:4	PO:5	PO:6	PO:7	PO:8	PO:9	PO:10	PO:11	PO:12	PSO:13	PSO:14
CO: 1	1	1	3	1	1	1	1	1	1	1	1	1	1	1
CO: 2	1	1	3	1	1	1	1	1	1	1	1	1	1	1
CO: 3	1	1	3	1	1	1	1	1	1	1	1	1	1	1
CO: 4	1	1	3	1	1	1	1	1	1	1	1	1	1	1
CO: 5	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CO 6	1	1	1	1	1	1	1	1	1	1	1	1	1	1

CO attainment levels

CO	Attainment levels
CO:1	3
CO:2	3
CO:3	4
CO: 4	4
CO: 5	5
CO: 6	3

Future Courses Mapping:

Advanced design, Design with assistance of sotware

Job Mapping:

In design, In Engineering Project company industry

Software based Chemical industry

In scale up of plant in consultancy industry

FF No. : 654

CH3236::SEPARATION TECHNIQUES

Course Prerequisites: Heat Transfer, Chemical Engineering Thermodynamics, Fluid Flow Operations, Mass transfer 1

Course Objectives:

1. To understand and apply principles of mass transfer operations
2. To generate the input data for design of separation columns
3. To design the separation columns for distillations, extraction, leaching and adsorption
4. To analyse the factors affecting separation
5. To understand working of industrial separation equipments

Credits: 4

Teaching Scheme Theory: 2 Hours/Week
Tut: 1 Hour/Week
Lab: **2** Hours/Week

Course Relevance:

Separation Techniques play a vital role in many industrial processes. Separation is crucial for the quality of desired product. A group of operations are carried out for separating the components of mixtures and is based on the transfer of material from one phase to another.

SECTION-1
Topics and Contents *Distillation: Vapour – liquid equilibria for ideal and non-ideal systems, relative volatility, methods of distillation - differential, flash, low pressure, batch rectification. Continuous rectification for binary system, multistage (tray) towers, Lewis Sorrel method, McCabe Thiele method, concept of reflux, Fenske's equation, Fenske-Underwood equation, use of open steam. Partial and total Condensers, reboilers. Ponchon Savarit method for multistage operations, tray efficiencies, packed column design, complex distillation columns, concept of multi component distillation, extractive and azeotropic distillation, Fenske- Underwood-Gilliland shortcut method for multi-component distillation.* *Liquid-Liquid Extraction: Ternary liquid-liquid equilibrium, triangular coordinates, single-stage extraction, Multi-stage crosscurrent extraction, continuous countercurrent multistage extraction. Types of extractors.*

SECTION-1I

Topics and Contents

Solid-Liquid Extraction: Single stage leaching, continuous counter current leaching, ideal stage equilibrium, operating time, constant and variable underflow, number of ideal stages, stage efficiencies, Leaching equipments.
Adsorption: Physical and chemical adsorption, adsorbents, adsorption equilibrium and isotherms, Single-stage, multi-stage cross-current and multi-stage counter current operations, equilibrium and operating lines, Liquid-solid agitated vessel adsorber, packed continuous contactor, breakthrough curves, Rate equations for adsorbents, nonisothermal operation, pressure-swing adsorption, Ion Exchange- Principles of Ion Exchange Equilibria and rate of ion exchange

List of Practicals: (Any Six)

1. To generate VLE data for binary ideal/non-ideal systems
2. To study ASTM Distillation
3. To determine Column Tray Efficiency for distillation
4. To generate equilibrium data for liquid-liquid extraction
5. To study solid-liquid mass transfer with/without chemical reaction
6. To verify Freundlich/ Langmuir isotherm equation for batch adsorption
7. To study differential distillation and verify Rayleigh equation
8. To study / carry out steam distillation of substance and determine steam requirement
9. To conduct binary distillation in a packed column at total reflux and to estimate HETP and HTU for column
10. To obtain data for equilibrium distribution of solute in two insoluble solvents for example acetic acid in water and toluene phases and determine percentage extraction
11. To study the (cross current) liquid- liquid extraction for extracting acetic acid from benzene using water as solvent
12. To carry out leaching operation using groundnuts and n-Hexane and find out quantity of oil and to determine the efficiency of single stage leaching operation
13. To obtain the breakthrough curve for continuous process in adsorption column
14. To study the operation of a batch rectification column under constant or total reflux condition

List of Projects:

1. Design of distillation column
2. Ternary diagram for a system of three liquid one pair partially soluble for example acetic acid, benzene and water system
3. Study liquid- liquid extraction in a packed column and determine HTU and HETP for the tower
4. Analysis of ion-exchange equilibria
5. Analysis of multi-component distillation system
6. Process design of leaching equipment
7. Process design of adsorption equipment
8. Analysis of vapour liquid equilibria
9. Design and simulation of reactive distillation
10. Analysis and Design of hybrid separation processes
11. Design and analysis of Supercritical Extraction Units
12. Process Design of Solvent Extractors
13. Design and Simulation of Extractive Distillation

List of Course Seminar Topics:

1. Production of ethanol to blend in gasoline
2. Oil and gas value chain
3. Solar distillation
4. Industrial application of leaching operation
5. Multicomponent distillation
6. Ion exchange resins and its industrial application
7. Role of vacuum distillation unit in refinery
8. Solvent Extraction: A potential separation technique
9. Importance of isotherms and breakthrough curve in adsorption
10. Pressure swing adsorption and applications
11. Atmospheric distillation unit in refinery
12. Finer selection of solvents for solvent extraction
13. Separation techniques in Fertilizer industry
14. Separation applications by Ion exchange process
15. Separation Techniques in pharmaceutical industry

List of Home Assignments:

Design:

1. Tray type Distillation Column
2. Packed type Distillation Column
3. Solvent Extraction Column
4. Leaching Column
5. Adsorption Column

Case Study:

1. Industrial separation equipments for gaseous mixture
2. Separation processes in chemical plant
3. Development of novel separation techniques
4. Competing separation techniques
5. Industrial separation equipments for liquid mixtures

Blog

1. Recent developments in distillation processes
2. Adsorption Isotherms and their interpretations
3. Use of Green Technology in Separation Processes
4. Improvements in conventional leaching techniques
5. Hybrid separation Techniques used in Industry

Surveys

1. Comparison between azeotropic distillation and solvent extraction for separation of azeotropes
2. Application of leaching in food processing industries
3. Solvent choice in liquid-liquid extraction
4. Use of leaching process in small scale industries
5. 5. Alternative to adsorption process used in industry

Suggest an assessment Scheme:

ESE	*HA*	*CP*	*VIVA*	*SEM*
20	*20*	*20*	*20*	*20*

ESE - End Semester Examination

HA - Home Assignment

CP - Course Project

VIVA - Viva voice

SEM – Seminar

Text Books: ***(As per IEEE format)***

1. Treybal R. E.; Mass Transfer Operations, Third edition, McGraw Hill, 1980
2. Coulson J. M., Richardson J. F.; Chemical Engineering – Vol. I & II, Sixth edition, Butterworth Heinemann, 1999
3. King C.J.; Separation Processes; Tata McGraw - Hill Publishing Co. Ltd., 1982.
4. 4. Dutta B. K.; Principles of Mass Transfer and Separation Processes; Prentice-Hall of India Private Ltd., 2007

Reference Books: ***(As per IEEE format)***

1. McCabe W. L., Smith J. C., Harriett P.; Unit Operations of Chemical Engineering; Fourth edition, McGraw-Hill, 1985.
2. Wankat. P.C.; Separations in Chemical Engineering: Equilibrium Staged Separations; Prentice Hall, NJ, US, 1988
3. 3. Perry R. H., Green D. W.; Perry's Chemical Engineer's Handbook; Sixth Edition, McGraw-Hill, 1984

Moocs Links and additional reading material: www.nptelvideos.in
https://swayam.gov.in/nd1_noc19_ch31/preview

Course Outcomes:
The student will be able to –

1. Generate VLE data for ideal and non-ideal system
2. Carry out process design of distillation column and analyze implications of factors affecting distillation column and also the implications of non-ideal phase behavior
3. Select suitable solvent for liquid-liquid extraction and design liquid-liquid extraction column and select equipment required for given separation
4. Calculate the number of stages required for a leaching operation
5. Carry out process design of adsorption column
6. Draw analogy between adsorption and ion exchange and analyze ion exchange equilibria

CO PO Map

CO/ PO	PO: 1	PO: 2	PO: 3	PO: 4	PO: 5	PO: 6	PO: 7	PO: 8	PO: 9	PO: 10	PO: 11	PO: 12	PSO :13	PSO :14
CO: 1	2	2	2	2	2	1	1	2	2	2	0	1	2	1
CO: 2	2	2	2	2	2	1	1	2	2	2	0	1	3	1
CO: 3	2	2	2	2	2	1	1	2	2	2	0	1	3	1
CO: 4	2	2	2	2	2	1	1	2	2	2	0	1	3	1
CO: 5	2	2	2	2	2	1	1	2	2	2	0	1	3	1
CO: 6	2	2	2	2	2	1	1	2	2	2	0	1	3	1

CO attainment levels

CO	Attainment level
CO:1	**4**
CO:2	**5**
CO:3	**5**
CO:4	**5**
CO:5	**5**
CO:6	**5**

Future Courses Mapping:
Mass Transfer with Chemical reactions, Petroleum Refining, Advanced Separation Techniques, Advanced Transport Phenomena

Job Mapping:
Industries like refineries, pharmaceuticals, paint, fertilizers, chemicals, automobiles etc

FF No. : 654

CH3238::CHEMICAL REACTION ENGINEERING

Course Prerequisites: Chemical reaction kinetics, numerical methods

Course Objectives:

1. Apply knowledge of RTD to diagnose non ideal reactors and selection of appropriate models to predict conversion from different reactors
2. Apply principles and kinetic tools in analyzing the rates of chemical reactions for
3. heterogeneous reactions
4. Demonstrate catalytic phenomena with extensions to surface chemistry,
5. Selection of a model for gas-solid non catalytic reactions and apply it to design
6. reactors
4. Determine fluid -fluid reaction rate equations and apply to equipment design
5. Design various types of catalytic reactors

Credits:4

Teaching Scheme Theory: 2. Hours/Week

Tut:1... Hours/Week

Lab: **2..** Hours/Week

Course Relevance: Chemical reaction engineering is an advanced course of undergraduate chemical engineering curriculum, which is concerned with the exploitation of chemical reactions on a commercial scale. Chemical Process economics depends upon the selection and design of a chemical reactor.

SECTION-1

Non-Ideal flow Heterogeneous processes, catalysis and adsorption

Residence time distribution in vessels: E, F and C curve, and their relationship for closed vessels, conversion in reactors having non-ideal flow; models for non-ideal flow: Dispersion model, Tank in Series, model, mixing of fluids, two parameter model, mixing of two miscible fluids. Global rate of reaction, Types of Heterogeneous reactions Catalysis, The nature of catalytic reactions, Adsorption: Surface Chemistry and adsorption, adsorption isotherm, Rates of adsorption. Solid catalysts: Determination of Surface area, Void volume and solid density, Pore volume distribution, Theories of heterogeneous catalysis, Classification of catalysts, Catalyst preparation, Promoters and inhibitors, Catalyst deactivation (Poisoning), Mechanism of deactivation, Rate equation for deactivation, Regeneration of catalyst.

SECTION-1I

Fluid-particle noncatalytic, catalytic and fluid-fluid non-catalytic reactions

Selection of a model for gas-solid non catalytic reaction, Un-reacted core model, Shrinking core model, Rate controlling resistances, Determination of the rate controlling steps, Application of models to design problems. Various contacting patterns and their performance equations, Introduction to heterogeneous fluid - fluid reactions, Rate equation for eight kinetic regimes i.e. instantaneous, Fast and slow reaction, Equipment used in fluid- fluid contacting with reaction, Application of fluid -fluid reaction rate equation to equipment design, Towers for fast reaction, Towers for slow reactions. Introduction of fluid particle catalytic reactions, Rate equation, Pore diffusion controlling, Heat effects during reaction, Various types of catalytic reactors construction, operation and design, Isothermal operation in Fixed bed reactor, Fluidized bed reactor, Slurry reactor, Trickle bed reactor, Experimental methods for finding rates.

List of Practical: (Any Six)

1. To study residence time distribution (RTD) in a CSTR and to find out peclet Number
2. To study residence time distribution (RTD) in a plug flow reactor
3. To determine RTD of a packed bed reactor and to find out Peclet No.
4. To determine RTD of CSTRs in series
5. To determine number of tanks in series equivalent to a real PFR
6. To determine heterogeneous reaction kinetics by LHHW approach
7. ASPEN simulation of Packed bed reactor
8. Study of a fluidized bed reactor and its performance
9. Case study of a trickle bed reactor
10. Adsorption isotherms

List of Projects:

1. Synthesizing a rate law, mechanism and rate limiting step for heterogeneous reactions.
2. Design of fluid- fluid reactors and Simulation using ASPEN
3. Design of fluid- particle reactors and Simulation using ASPEN
4. Catalyst preparation and adsorption isotherms
5. Conversion prediction by Dispersion Model
6. Study of Scale up processes for nano particle synthesis
7. Design of a fermentor
8. Multiple reactions in CSTR with heat effects
9. Design and simulation of a fixed bed reactor
10. Design and simulation of a fluidised bed reactor
11. Conversion prediction by T-I-S model
12. Conversion prediction by segregation model
13. Conversion prediction by maximum mixedness model
14. Diagnosis of reactors using RTD curves
15. Design of slurry reactor

List of Course Seminar Topics:

1. Modern nuclear reactors
2. Poisoning, Deactivation, regeneration and deactivation rate determination
3. Membrane bioreactors and it's application in wastewater treatment
4. Role of Chemical reaction engineering in pollution prevention
5. Recent catalyst Characterization techniques
6. Reactive Distillation
7. Reactive Absorption
8. Reactive Extraction
9. Nano materials and it's application in chemical reaction engineering
10. Micro reactors and its application
11. Scope of Chemical reaction engineering in sustainable development
12. Adsorption process and it's application
13. Advances in chemical reactors
14. Scope of Chemical reaction engineering in biotechnology
15. Membrane bio reactors

List of Home Assignments:

Design:

1. Design of fixed bed reactor
2. Design of fluidised bed reactor
3. Design of Trickle bed reactor
4. Design of slurry reactor
5. Design of solid fluid reactors

Case Study:

1. Catalytic reactors used in petroleum industries
2. Synthesis of nanoparticles by various methods
3. Fisher Tropsch reaction in slurry reactor
4. Challenges in manufacturing of polymers
5. Coal hydrogenation in slurry reactor

Blog

1. Any advanced technique used in process intensification in a chemical process
2. Modern reactors in chemical industries
3. Heat exchange facilities for highly exothermic reactions in fixed bed reactor
4. Recent trends in chemical reaction engineering
5. Softwares used in chemical reaction engineering

Surveys

1. Reactors used in Polymer industries
2. Digitalisation in Chemical industries
3. Membrane reactors and it's applications in chemical industries
4. Polymers and it’s applications
5. Nano bio materials and it’s application

Suggest an assessment Scheme:

ESE	*HA*	*CP*	*VIVA*	*GD*
20	*20*	*20*	*20*	*20*

Text Books: ***(As per IEEE format)***

1. Levenspiel, O., 'Chemical Reaction Engineering', 3rd. edition, John Wiley& Sons, 2001.
2. Fogler, H. S., 'Elements of Chemical Reaction Engineering', 3rd Ed., PHI, 2002.
3. 3.Smith, J.M., 'Chemical Engineering Kinetics', 3rd ed., McGraw Hill, 1987.

Reference Books: ***(As per IEEE format)***

1. Walas, S. M., 'Reaction Kinetics for Chemical Engineers', McGraw Hill, 1959.
2. 2.Fromment G.F. and Bischoff K.B., Chemical Reactor Analysis and Design, John Wiley 1994.
3. 3.Sharma, M.M. and Doraiswamy, L.K. Heterogeneous reactions: Analysis, Examples and
4. Reactor Design. Vols. I & II, John Wiley and Sons, NY, 1984.

Moocs Links and additional reading material: www.nptelvideos.in

https://www.edx.org/course/technology-innovation-sustainable-epflx-innov4devx

Course Outcomes:

Course Outcomes:

The student will be able to –

1. Distinguish between various RTD curves and predict the conversion from a non-ideal reactor using tracer information
2. Calculate the global rate of heterogeneous catalytic reactions
3. Determine the characteristics of solid catalyst like surface area, porosity, pore volume, etc
4. Select model for fluid-particle reactions and design the fluid particle reactors
5. Select model for fluid-fluid reactions and design columns and tanks
6. Design fixed bed and fluidized bed reactor

CO PO Map

CO/PO	PO:1	PO:2	PO:3	PO:4	PO:5	PO:6	PO:7	PO:8	PO:9	PO:10	PO:11	PO:12	PSO:13	PSO:14
CO:1	1	2	2	2	2	1	1	2	2	2	0	1	2	1
CO:2	1	2	2	2	2	1	1	2	2	2	0	1	3	1
CO:3	2	2	2	2	2	1	1	2	2	2	0	1	3	1
CO:4	2	2	2	2	2	1	1	2	2	2	0	1	3	1
CO:5	2	2	2	2	2	1	1	2	2	2	0	1	3	1
CO:6	2	2	2	2	2	1	1	2	2	2	0	1	3	1

CO attainment levels

CO	Attainment level
CO:1	4
CO:2	5
CO:3	4
CO:4	5
CO:5	4
CO:6	5

Future Courses Mapping:

Advanced reaction engineering, Petroleum refining and petrochemicals technology, Bioengineering, Environment engineering

Job Mapping:

Student can work in chemical, petrochemical, pharmaceutical, fertilizer, biochemical industries

FF No. : 654

CH3288::ENGINEERING DESIGN AND INNOVATION VI

Course Prerequisites: Basic principles of physics, mathematics, chemistry, heat transfer

Course Objectives:

The Students will be able to

1. Do literature search appropriately with available tools
2. Defining of project title/idea
3. Allocation of tasks among the team members

4. Team spirit development
5. Write a report, research paper with required format
6. Present work effectively with concrete results

Credits: 04 **Teaching Scheme Theory: …..** Hours/Week

Tut: ……... Hours/Week

Lab: **8** Hours/Week

Course Relevance: Engineering Design and development is specially design part of curriculum, that will facilitate application of theory concept in practice. This is project based learning experience. As in practical situation, where first project is defined and then respective required skilled are learned to accomplish the project. We are making student ready to face and approach actual problem.

SECTION-1&II
Topics and Contents *This stage will include a complete report consisting of synopsis, the summary of the literature survey carried out, Details of experimental/theoretical work and results and discussion and conclusion.* *Students may undertake studies in application chemical engineering knowledge for manufacturing project, synthesis, design and development, experimental work, testing on the product or system, generation of new ideas and concept, modification in the existing process/system, development of computer programs, solutions, modeling and simulation related to the subject. Topics of interdisciplinary nature may also be taken up. A detailed literature survey is expected to be carried out as a part of this work. The group of students is required to choose the topic in consultation with the Guide.* *A technical report of 15 pages is required to be submitted at the end of the term and a presentation made based on the same. Modern audio-visual techniques may be used at the time of presentation.* *The external from Industry/research organization is invited to evaluate the projects done by students.*

List of Project areas:

1. Agriculture
2. Personal Health
3. Social health
4. Hygiene
5. Energy
6. Environment
7. Potable Water
8. Solar based
9. Modeling and Simulation
10. Waste water treatment
11. Air pollution
12. Solid waste management
13. Low-cost product development

Suggest an assessment Scheme:

Assessment of Engineering Design and Innovation project includes three reviews spread across 4 months, where research innovative ideas, strategy of execution, actual execution, teamwork is assessed.

Every review is based on report writing, presentation of results and team work demonstration.

Two reviews are with internal faculty members
Third review is with an external industry expert.

Review 1: Literature search and deciding appropriate topic
Review 2: Progress of work on decided topic i.e setting experimental setup, developing methodology of solving the opted problem.
Review 3: Overall assessment of project work with team efforts.

Moocs Links and additional reading material: www.nptelvideos.in

7. https://nptel.ac.in/courses/103/103/103103039/#watch
8. https://www.honeywellprocess.com/en-US/explore/solutions/integrated-technology/Pages/leap.aspx
9. https://www.gtu.ac.in/uploads/GIC%20Compendium%20IDP-UDP.pdf
10. https://www.udemy.com/course/leadership-psychology-cultivate-creativity-and-innovation/
11. https://www.coursera.org/learn/uva-darden-project-management
12. https://www.coursera.org/specializations/innovation-creativity-entrepreneurship

Course Outcomes: The student will be able to –

1. Apply chemical engineering knowledge.
2. Learn how to work in a team.
3. Define a task (problem) and execute it.

4. Carry out literature search related to topic.
5. Write synopsis and complete literature search related to topic and complete report.
6. Present the outcome of work systematically in a team.

CO PO Map

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14
CO1	3	1	1	1	0	1	1	1	1	1	1	1	1	1
CO2	0	0	0	0	0	0	0	2	3	1	3	1	0	0
CO3	3	1	1	1	1	1	1	1	1	1	1	1	1	1
CO4	1	3	1	1	1	1	1	1	1	1	1	1	1	1
CO5	1	1	1	1	1	1	1	1	1	3	1	1	1	1
CO6	1	1	1	1	1	1	1	1	1	2	1	1	1	1

CO attainment levels

CO	Attainment level
1	2
2	3
3	3
4	5
5	5
6	4

Future Courses Mapping:

Next semester project, BTech course project

Job Mapping:

What are the Job opportunities that one can get after learning this course
Core Chemical Engineering industrial job
Chemical Engineering Design job
Chemical Engg. research jobs

FF No. : 654

CH3292::DESIGN THINKING 2

Course Prerequisites: Basic principles of Science

Course Objectives:

To provide ecosystem for paper publication and patent filing

Credits: 04 **Teaching Scheme** **Tut: 1** Hours/Week

Course Relevance: To assist for publication of research paper or patent

SECTION-1&II
Topics and Contents *Students may undertake studies in application chemical engineering knowledge for manufacturing project, synthesis, design and development, experimental work, testing on the product or system, generation of new ideas and concept, modification in the existing process/system, development of computer programs, solutions, modeling and simulation related to the subject. Topics of interdisciplinary nature may also be taken up. A detailed literature survey is expected to be carried out as a part of this work. The group of students is required to choose the topic in consultation with the Guide.* *A paper/patent is required to be published at the end of the term and a presentation made based on the same. Modern audio-visual techniques may be used at the time of presentation.* *The external from Industry/research organization is invited to evaluate the projects done by students.*

List of Project areas:

1. Agriculture
2. Personal Health
3. Social health
4. Hygiene
5. Energy
6. Environment
7. Potable Water
8. Solar based
9. Modeling and Simulation
10. Waste water treatment
11. Air pollution
12. Solid waste management
13. Low-cost product development

Suggest an assessment Scheme:

Moocs Links and additional reading material: www.nptelvideos.in

Course Outcomes: The student will be able to –

1. Understand the importance of doing Research
2. Interpret and distinguish different fundamental terms related to research
3. Apply the methodology of doing research and mode of its publication
4. Write a Research Paper based on project work
5. Understand Intellectual property rights
6. Use the concepts of Ethics in Research
7. Understand the Entrepreneurship and Business Planning

CO PO Map

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14
CO1	1	1	1	1	1	0	0	0	0	0	0	1	1	1
CO2	1	1	1	1	1	0	0	0	0	0	0	1	1	1
CO3	2	2	3	3	2	2	1	2	2	3	0	1	1	1
CO4	3	3	3	3	3	2	1	2	2	3	1	1	1	1
CO5	1	1	1	1	1	0	0	0	0	0	0	1	0	0
CO6	2	2	2	2	2	2	1	3	2	3	0	1	0	0
CO7	1	1	1	1	1	0	0	0	0	0	0	1	0	0

CO attainment levels

CO	Attainment level
1	2
2	2
3	3
4	5
5	2
6	3
7	2

Future Courses Mapping:

Next semester project, BTech course project

Job Mapping:

What are the Job opportunities that one can get after learning this course
Core Chemical Engineering industrial job
Chemical Engineering Design job
Chemical Engg. research jobs